

# **Illustration of market distortions under a cap & trade regime**

(April 2005)

## **How to reduce emissions under PSR**

(November 2005)

## **Effectiveness and fuel switch under different ETS options for electricity**

(February 2006)

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## Illustration of market distortions under a cap & trade regime

Revision April 2, 2005

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### Introduction

There are two sources of potential distortions:

- Market share changes
- Efficiency changes

The consequences of such changes under a cap & trade regime are illustrated by calculating the cost price distortions and by comparing these with trade under a PSR-method (Performance Standard Rate) and auctioning.

Under auctioning a market share winner needs to buy more allowances and the market share loser can sell allowances. The same happens under a cap & trade system. However, this is a totally different situation as will be illustrated in this paper.

### The first example

Let us assume two companies A and B, which produce the same product or product range with the same efficiency and the same emission. Both companies are rather efficient and cannot afford investments for reduction projects until a price of € 25/ton CO<sub>2</sub>. Let us further assume an emission of 3 mln tonnes CO<sub>2</sub> per annum and a production of 3 mln tonnes as well.

### Auctioning and market share changes

Under auctioning companies need to purchase all allowances. They bid for allowances on the basis of their production forecasts and as the price for CO<sub>2</sub> is rising they bid for a lower amount whilst they bring in investments for reduction projects. Company A and B are both very efficient and have no reduction projects until a price of € 25/ton CO<sub>2</sub>. The initial market price is established when the market demand for allowances meets the market supply. Because of the lead time of projects the auction needs to be held several years ahead, however such and other circumstances of auctioning are beyond the scope of this paper.

The cost implications of a change of market share are illustrated below.

<b>Illustration of the effect of changes of market share under auctioning</b>			
	Units	Company A	Company B
Production forecast	Kton product	3,000	3,000
Emission forecast	Kton CO <sub>2</sub>	3,000	3,000
Market price	€/ton CO <sub>2</sub>	25	25
Initial cost based on forecasts	€ x 1000	75,000	75,000
Cost price effect	€/ton product	25	25
<b>Initial market distortion (+ = advantage)</b>	€ x 1000	0	0
Actual realised production after change of market share	Kton product	3,500	2,500
Actual realised emission	Kton CO <sub>2</sub>	3,500	2,500
Purchase (-) and sales (+) of allowances	Kton CO <sub>2</sub>	-500	+500
Purchase (-) and sales (+) of allowances (assume same market price)	€ x 1000	-12,500	+12,500
Net cost after change of market share	€ x 1000	87,500	62,500
Cost price effect	€/ton product	25	25
<b>Market distortion (+ = advantage)</b>	€ x 1000	0	0

### Cap & trade and market share changes

Let us now assume that both companies get their allowances free of charge for the reference year, which was equal to their forecasts. In other words, both companies had an emission of 3 mln tonnes CO<sub>2</sub> per annum, a production of 3 mln tonnes in the reference year and they have forecasted this to remain so for the immediate future.

<b>Illustration of the effect of changes of market share under cap &amp; trade</b>			
	Units	Company A	Company B
Production reference year	Kton product	3,000	3,000
Emission reference year	Kton CO <sub>2</sub>	3,000	3,000
Cap	Kton CO <sub>2</sub>	<b>3,000</b>	<b>3,000</b>
Market price	€/ton CO <sub>2</sub>	25	25
Initial cost based on forecasts	€ x 1000	0	0
Cost price effect	€/ton product	0	0
<b>Initial market distortion (+ = advantage)</b>	€ x 1000	0	0
Actual realised production after change of market share	Kton product	3,500	2,500
Actual realised emission	Kton CO <sub>2</sub>	3,500	2,500
Purchase (-) and sales (+) of allowances	Kton CO <sub>2</sub>	-500	+500
Purchase (-) and sales (+) of allowances (assume same market price)	€ x 1000	-12,500	+12,500
Net cost after change of market share	€ x 1000	-12,500	+12,500
Cost price effect	€/ton product	-3.57	+5.00
<b>Market distortion versus each other (+ = advantage)</b>	€ x 1000	-25,000	+25,000

In this example the cost difference between company A and B is €25 mln in the particular year. This is the damage for company A versus company B as a result of the change of market share. This damage is considered to be a serious distortion of competition.

Cap & trade acts like a cartel<sup>1</sup> for the established producers: winners of market share by better marketing or by technology innovation are required to pay penalties to the losers of market share. At a meaningful price for CO<sub>2</sub> frozen market shares are enhanced.

This hinders the free market as guaranteed in the EC Treaty without any environmental justification. On the contrary, more efficient producers are often the winners of market share; the cap system therefore hinders the climate objective to lower emissions.

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<sup>1</sup> Prof. Ströbele mentions this in the study "Zertifikatenhandel für CO<sub>2</sub>-emissionen auf dem Prüfstand" (page 38). He argues that the EU has copied the mechanism of the "Seven Sisters" in the fifties and sixties to protect their market shares by a cartel. This study was executed on request of RWE, E.ON, Vattenfall Europe, Degussa, BASF and several industry associations.

### PSR-method and market share changes

Let us now assume that both companies were more efficient than the PSR, in other words they can be sellers of allowances. For reasons of simplicity we assume a PSR on the basis of ton CO<sub>2</sub>/ton product.

<b>Illustration of the effect of changes of market share under the PSR-method</b>			
	Units	Company A	Company B
Production forecast	Kton product	3,000	3,000
Emission forecast	Kton CO <sub>2</sub>	3,000	3,000
PSR	Ton CO <sub>2</sub> /ton product	1.1	1.1
PSR forecast	Kton CO <sub>2</sub>	3,300	3,300
Initial sales of allowances, assume both companies have sold this amount ahead	Kton CO <sub>2</sub>	300	300
Market price	€/ton CO <sub>2</sub>	25	25
Initial value based on forecasts	€ x 1000	7,500	7,500
Cost price effect	€/ton product	-2.5	-2.5
<b>Initial market distortion (+ = advantage)</b>	€ x 1000	0	0
Actual realised production after change of market share	Kton product	3,500	2,500
Actual realised emission	Kton CO <sub>2</sub>	3,500	2,500
PSR	Ton CO <sub>2</sub> /ton product	1.1	1.1
PSR actual realised production	Kton CO <sub>2</sub>	3,850	2,750
Additional purchase (-) and sales (+) of allowances	Kton CO <sub>2</sub>	+50	-50
Additional purchase (-) and sales (+) of allowances (assume same market price)	€ x 1000	+1,250	-1,250
Net cost after change of market share	€ x 1000	8,750	6,250
Cost price effect	€/ton product	-2.5	-2.5
<b>Market distortion (+ = advantage)</b>	€ x 1000	0	0

There is no cost price difference as long as the efficiencies of the two companies are the same. Any change of market share has no influence on the competitive situation.

**Like auctioning, the PSR-method is based upon the actual realised production and the actual realised efficiency.**

### The second example

Let us now assume two companies A and B, which produce the same product or product range. Company A is now more efficient than company B. It appears that company B can afford reduction investments.

### Auctioning and efficiency changes

<b>Illustration of the effect of changes of efficiency under auctioning</b>			
	Units	Company A	Company B
Production forecast	Kton product	3,000	3,000
Emission forecast	Kton CO <sub>2</sub>	2,700	3,300
Market price	€/ton CO <sub>2</sub>	25	25
Initial cost based on forecasts	€ x 1000	67,500	82,500
Cost price effect	€/ton product	22,5	27,5
<b>Initial cost price advantage versus each other (+ = advantage)</b>	€ x 1000	+15,000	-15,000
Actual realised situation after change of efficiency	Kton product	3,000	3,000
Actual realised emission	Kton CO <sub>2</sub>	2,700	2,700
Purchase (-) and sales (+) of allowances	Kton CO <sub>2</sub>	0	+600
Purchase (-) and sales (+) of allowances (assume same market price)	€ x 1000	0	+15,000
Net cost after change of efficiency	€ x 1000	62,500	62,500
Cost price effect	€/ton product	22,5	22,5
<b>Market distortion in case of equal efficiency (+ = advantage)</b>	€ x 1000	0	0

The initial and final cost price difference between company A and B reflects the “polluter-pays” principle. This is required by European law (art. 174 EC Treaty). Company A has initially a cost price advantage because of the better efficiency. Company A is rewarded for its early action with the same yardstick as is applied for company B.

It could be argued that company B cannot change their efficiency overnight. Therefore it could be considered to allow for some lead-time, for example 4 years. To avoid distortions under a cap & trade regime as illustrated before, the initial allocation could be considered to be based on the initial efficiency of each company. This could be achieved by applying the PSR-method instead of auctioning during the first 4-5 years.

Anyhow, as soon as company B has undertaken sufficient reduction projects the cost price disadvantage with company A can be eliminated. Company B has the possibility to execute reduction investments or to purchase the corresponding amount of allowances whilst avoiding investments.

### Cap & trade and efficiency changes

<b>Illustration of the effect of changes of efficiency under cap &amp; trade</b>			
	Units	Company A	Company B
Production reference year	Kton product	3,000	3,000
Emission reference year	Kton CO <sub>2</sub>	2,700	3,300
Cap	Kton CO <sub>2</sub>	<b>2,700</b>	<b>3,300</b>
Market price	€/ton CO <sub>2</sub>	25	25
Initial cost based on reference year	€ x 1000	0	0
Cost price effect	€/ton product	0	0
<b>Initial cost price advantage versus each other (+ = advantage)</b>	€ x 1000	0	0
Actual realised situation after change of efficiency	Kton product	3,000	3,000
Actual realised emission	Kton CO <sub>2</sub>	2,700	2,700
Purchase (-) and sales (+) of allowances	Kton CO <sub>2</sub>	0	+600
Purchase (-) and sales (+) of allowances (assume same market price)	€ x 1000	0	+15,000
Net cost after change of efficiency	€ x 1000	0	-15,000
Cost price effect	€/ton product	0	5.0
<b>Market distortion in case of equal efficiency (+ = advantage)</b>	€ x 1000	-15,000	+15,000

Under the cap & trade regime company B has the possibility to achieve a cost price advantage of € 15 mln/year. This is caused by the absence of the reward for early action for company A. The absence of an initial cost price difference is not in accordance with the “polluter-pays” principle.

In contrast with company B, company A cannot execute projects anymore to achieve the emission of 2,700 kton CO<sub>2</sub>, which lead to sales of allowances. Company A has already realised this emission. Therefore company A needs to become rewarded for its early action.

In case early action is rewarded a common efficiency standard – a PSR – is required. This would eliminate distortions created by efficiency differences. What remains under cap & trade are potential distortions in case of market share changes.

### PSR-method and efficiency changes

<b>Illustration of the effect of changes of efficiency under the PSR-method</b>			
	Units	Company A	Company B
Production forecast	Kton product	3,000	3,000
Emission forecast	Kton CO <sub>2</sub>	2,700	3,300
PSR	Ton CO <sub>2</sub> /ton product	1.1	1.1
PSR forecast	Kton CO <sub>2</sub>	3,300	3,300
Initial sales of allowances, assume both companies have sold this amount ahead	Kton CO <sub>2</sub>	600	0
Market price	€/ton CO <sub>2</sub>	25	25
Initial value based on forecasts	€ x 1000	15,000	0
Cost price effect	€/ton product	-5.0	0
<b>Initial cost price advantage versus each other (+ = advantage)</b>	€ x 1000	+15,000	-15,000
Actual realised situation after change of efficiency	Kton product	3,000	3,000
Actual realised emission	Kton CO <sub>2</sub>	2,700	2,700
PSR	Ton CO <sub>2</sub> /ton product	1.1	1.1
PSR actual realised production	Kton CO <sub>2</sub>	3,300	3,300
Additional purchase (-) and sales (+) of allowances	Kton CO <sub>2</sub>	0	+600
Additional purchase (-) and sales (+) of allowances (assume same market price)	€ x 1000	0	+15,000
Net cost after change of efficiency	€ x 1000	-15,000	-15,000
Cost price effect	€/ton product	-5.0	-5.0
<b>Market distortion in case of equal efficiency (+ = advantage)</b>	€ x 1000	0	0

The initial and final cost price difference between company A and B reflects the “polluter-pays” principle and is exactly the same as under auctioning. This is required by European law (art. 174 EC Treaty). Company A has initially a cost price advantage because of the better efficiency.

It could be argued that company B cannot change their efficiency overnight. Therefore it could be considered to allow for some lead-time, for example 4 or 5 years. To avoid distortions under a cap & trade regime as illustrated before, the initial allocation could be considered to be based on the initial efficiency of each company. This can be achieved by applying the PSR-method.

Anyhow, as soon as company B has undertaken sufficient reduction projects the cost price disadvantage with company A can be eliminated. Company B has the possibility to execute reduction investments or to purchase the corresponding amount of allowances whilst avoiding investments.





# How to reduce emissions under PSR

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1 November 2005

## Introduction

The objectives of the EU emissions trading scheme are to enhance the economic development which is also the aim the Lisbon strategy, whilst at the same time to accomplish an absolute lowering of greenhouse gas emissions, for the 1<sup>st</sup> trading period limited to CO<sub>2</sub>.

The PSR method – Performance Standard Rate, an equal amount of allowances for an equal amount of production – is presented as an alternative for auctioning and for the cap & trade methods used in the current NAPs (national allocation plans) across the European Union.

## Tremendous innovation challenges for a carbon constrained economy

The absolute lowering of emissions whilst increasing welfare poses great technological and economical challenges. Support by an effective emissions trading scheme is vital.

It is common ground that all possibilities need to be addressed, such as: energy efficiency, carbon sequestration, biomass and renewables as well as nuclear (inherently safe & fusion). No single solution is believed to curb emissions in the coming decades to a level that is regarded safe to overcome the greenhouse gas problem. A new future needs to be invented.

Most industrial and other (domestic) processes have a great potential to improve efficiency and therefore to reduce emissions because of their still poor exergy efficiency, typically 10%<sup>1</sup>-20%. Ultimately novel breakthrough technologies are cheaper than current technologies, but they require great efforts, much lead-time and present high business risks.

When revamping existing installations higher efficiency concepts and novel technologies need to be applied faster than today. It is well known that the (energy) efficiency improves when capacity creep<sup>2</sup> projects are implemented. This is good for the competitive position of producers (lower fixed costs per unit of product) and good for the environment.

Carbon sequestration is most promising for a fast and drastic lowering of emissions as an intermediate solution for this century. This is an important instrument because it is unrealistic that the economy can prosper without coal, oil and gas in the 21<sup>st</sup> century. It needs vigorous development of possible technological alternatives, especially for carbon capture, to reduce total additional cost to no more than €20-25/ton CO<sub>2</sub> for example for clean coal plants. The 1<sup>st</sup> generation can be available by 2013-2015, but this date can possibly be brought forward with suitable support and unambiguous policies for emissions trading.

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<sup>1</sup> High efficiency boilers fuelled by natural gas for domestic heating have a thermal efficiency of around 95% of High Heating Value (even above 100% based on Low Heating Value), but the exergy efficiency is only around 10%. The precious primary energy is degraded to 20 °C heat instead of power. Therefore micro-CHP and heat pumps have a significant potential for improvement.

<sup>2</sup> Capacity creep means small increases of the capacity of existing production plants by investments to eliminate bottlenecks of the process. It often occurs in steps of a few percent up to 10% or more. Capacity creep is for example widely applied in the chemical industry, another example are nuclear power plants. This is an ongoing process executed multiple times during the lifetime of a plant, of say 40-50 years.

## Objectives Directive emissions trading

- Fitness for purpose, effectiveness in lowering emissions.
- A carbon constraint that results in efficiency improvements such as CHP<sup>3</sup> and innovation.
- Level playing field, no undue favouring of sectors and companies, a same allocation to same installations and safeguarding competition and unhampered trade between Member States.
- To contribute to the UN Framework Convention on Climate Change to achieve stabilisation of greenhouse gas concentrations in the atmosphere (recital 3).
- Polluter-pays principle: when granting allowances the potential to reduce emissions is to be taken into account.

To achieve these objectives, following conditions must be met:

- Innovative market players with a lower emission per unit of product get an incentive to win market share.
- Obsolete plants with a relatively high emission per unit of product to be replaced earlier than without emissions trading.
- Production from closed obsolete plants can be shifted to more efficient existing plants.
- New entrants to be unobstructed to proliferate more efficient and novel technologies.

Of course, the requirements to reduce emissions need to be balanced against the efforts undertaken elsewhere in the global market place; if not, the competitive position of the EU industry will be undermined.

## Present cap & trade allocation rules

Analysis shows that present allocation rules based on the cap & trade theory do not fulfil the objectives of emissions trading in general and the objectives of the Directive in particular. This is summarised in **appendix 1**.

It is concluded that there is no way in which this theory can comply with the objectives mentioned above. In addition, cap & trade rules would seem to be in conflict with the spirit if not the essential aims and requirements of the EC Treaty, where it concerns competitive distortion and state aid.

## The alternative of Performance Standard Rate (PSR) with ex-post control

All fundamental problems or undesired effects mentioned in appendix 1 do not occur when full auctioning would be applied. But auctioning is not an option as it would be detrimental to the competitive position of European industry on the global market. Therefore the alternative of PSR with ex-post control of the production is presented as the most feasible solution. This approach can be applied within the scope and the requirements of the Directive<sup>4</sup>, ready for use as from 2008.

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<sup>3</sup> Combined Heat & Power.

<sup>4</sup> The allocation becomes objective (Directive, art. 9) and conditional; conditional insofar the forecasted production is met.

## Outline of the PSR approach

Following benchmark formula will serve the purpose of avoiding competitive distortions, of achieving an effective trading scheme with unambiguous signals. It takes BAT into account and the potential of processes to near, equal or surpass BAT. (BAT in this context meant as the proven Best Practice).

- **Benchmark data: population under the scheme**
  - Currently EU-25, in future with Norway, Canada, Japan, South Korea, etc.
- **PSR = WAE – CF x (WAE – BAT)**
  - WAE = Weighted Average Efficiency
  - BAT = Best Available Technique (the proven Best Practice)
  - CF = Compliance Factor, equal for all PSRs, reflecting equal efforts between different types of installations<sup>5</sup>.
- **Compliance Factor**
  - 2008: CF = for example 3% to create a CO<sub>2</sub> market price
  - 2012: possibly 15%-25%<sup>6</sup>
  - CF will be adjusted annually for the future years to come.

The annual adjustment of the Compliance Factor takes into account:

1. A market price for allowances at a level, which encourages innovations and efficiency improvements to reduce emissions;
2. Total industrial emissions and the long-term objective function for industrial emissions as established by the competent authorities.

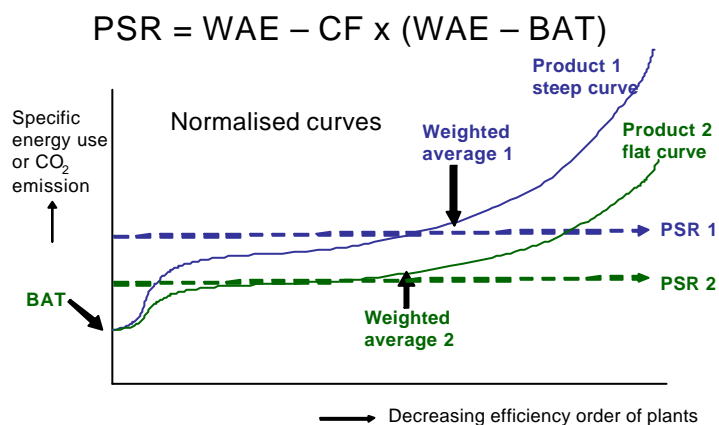
The formula takes account of different shapes of the efficiency curve for different products (the potential of processes in their path to BAT<sup>7</sup>):

Products with a steep curve have a higher potential to reduce emissions, products with a flatter curve have a lower potential.

By gradually increasing the CF the demand on all products is increased. Nevertheless it should be noted that achieving BAT for an entire population takes a long time. During this time the BAT tends to improve. BAT is a moving target.

The proposed approach provides unambiguous signals to producers:

- Efficiency improvement will always be rewarded;
- It is also rewarding to improve BAT, which is an important climate objective.



<sup>5</sup> To maintain the principle of equal effort between PSR's, regular up-dating of a PSR is required. With time, when the monitoring procedures under ETS are in place fully, the update of a PSR can become an annual, administrative routine.

<sup>6</sup> The stringency of the CF is within the limits of lead-time to reduce emissions a political decision; it depends also on the efforts undertaken elsewhere in the world.

<sup>7</sup> Therefore PSR = BAT + x% or PSR = average efficiency – y% are both unjust.

## The PSR example for electricity

Around 2007 the average emission of fossil-fuelled electricity within the EU-25 is estimated to be about 700 kg CO<sub>2</sub>/MWh. The Best Practice is around 250 kg CO<sub>2</sub>/MWh (CHP). By 2015 or some years earlier the Best Practice will be zero kg CO<sub>2</sub>/MWh for zero emission power plants. The use of the presented PSR formula enables and encourages this development.

With this approach CHP will bridge the gap until clean coal and gas plants are available. Schematically it is shown below how emissions can be lowered for electricity with PSR under ex-post control while the demand for electricity increases (estimations for EU-25):

Forecast EU-25	2002	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Coal with BAU MWe prod.	100,530	86,027	86,457	86,889	87,324	87,760	88,199	88,640	89,083	89,529	89,976	90,426
Co-firing biomass penetration			1.0%	3.0%	5.0%	7.0%	9.0%	11.0%	13.0%	15.0%	18.0%	20.0%
Possible reduction from co-firing biomass		Mton CO <sub>2</sub> 0.94	-7	-21	-36	-51	-65	-80	-95	-111	-133	-149
Co-firing biomass increase as from 2008			865	2,607	4,366	6,143	7,938	9,750	11,581	13,429	16,196	18,085
Normal coal & lignite		86,027	85,592	84,282	82,957	81,617	80,261	78,890	77,502	76,099	73,780	72,341
Gas incl. CHP	60,318	90,753	94,110	97,592	101,203	104,948	108,831	112,858	117,034	121,364	125,854	130,511
Oil	20,106	20,409	20,471	20,532	20,594	20,655	20,717	20,780	20,842	20,904	20,967	21,030
<b>Subtotal fossil-fuelled electricity in MWe</b>		<b>197,189</b>	<b>201,038</b>	<b>205,014</b>	<b>209,121</b>	<b>213,364</b>	<b>217,747</b>	<b>222,277</b>	<b>226,959</b>	<b>231,797</b>	<b>236,798</b>	<b>241,967</b>
Nuclear (Finland + capacity creep)	107,232	111,038	111,594	112,151	112,712	113,276	113,842	114,411	114,983	115,558	116,136	116,717
Renewables	43,563	53,001	54,591	56,229	57,916	59,653	61,443	63,286	65,185	67,140	69,155	71,229
Other	3,351	3,351	3,351	3,351	3,351	3,351	3,351	3,351	3,351	3,351	3,351	3,351
<b>Total MWe production</b>	<b>335,101</b>	<b>364,579</b>	<b>370,574</b>	<b>376,745</b>	<b>383,100</b>	<b>389,644</b>	<b>396,384</b>	<b>403,326</b>	<b>410,478</b>	<b>417,846</b>	<b>425,439</b>	<b>433,264</b>
Growth			1.64%	1.67%	1.69%	1.71%	1.73%	1.75%	1.77%	1.80%	1.82%	1.84%

	2002	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
<b>Total MWe in fossil with biomass</b>	180,954	197,189	201,038	205,014	209,121	213,364	217,747	222,277	226,959	231,797	236,798	241,967
<b>Total TWh in fossil with biomass</b>	1,585	1,727	1,761	1,796	1,832	1,869	1,907	1,947	1,988	2,031	2,074	2,120
<b>BAT (Best Practice)</b> ton / MWh		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0	0	0
<b>WAE</b> ton / MWh		0.69	BAT = Combined Heat & Power					BAT = Zero emission plants				
<b>CF (Compliance Factor)</b>		0%	4%	9%	15%	21%	27%	31%	22%	25%	28%	31%
<b>PSR = WAE - CF x (WAE - BAT)</b>	0.750	0.69	0.67	0.65	0.62	0.59	0.57	0.55	0.54	0.51	0.49	0.47
<b>Emission in Mton</b>	1,189	1,185	1,177	1,161	1,137	1,111	1,084	1,072	1,064	1,045	1,024	1,003
<b>Reduction in Mton</b>			-8	-23	-48	-74	-101	-112	-121	-140	-160	-182
<b>Average trading period reduction in Mton/annum</b>			-51					-143				

In this approach it is assumed and recommended that co-firing biomass in power plants is stimulated (which is not the case in current grandfathering methods). It is a clear possibility to lower long cycle emissions of existing power plants.

## The importance of ex-post control

In the presented PSR approach the amount of allowances is coupled to the realised amount of production. This works exactly the same as under auctioning; therefore PSR is a kind of partial auctioning without the detrimental effect on global competitiveness.

Under auctioning the cost-price difference between two producers or installations is defined by the difference of efficiency. Exactly the same is true for PSR; take the example of electricity as presented above. The cost-price difference between installation A and installation B:

$$(\text{Eff. A} - \text{PSR}) - (\text{Eff. B} - \text{PSR}) = \text{Eff. A} - \text{PSR} - \text{Eff. B} + \text{PSR} = \text{Eff. A} - \text{Eff. B} \text{ (q.e.d.)}$$

## Conclusions PSR with ex-post control

- The amount of allowances is coupled to future production;
- The environmental outcome is (virtually) assured<sup>8</sup> by limited annual adjustments of CF
- The lack of predictability for new entrants is completely eliminated;
- There is no need for transfer arrangements for new entrants;
- Windfall profits for electricity producers are eliminated, only the real cost must be paid;
- There is an unambiguous signal for striving to efficient designs and innovation;
- Efficient winners of market share are clearly stimulated;
- The PSR method obeys the polluter-pays principle.

<sup>8</sup> Under cap & trade the certainty of the outcome is not assured if the ex-ante cap appears ex-post to be too stringent (for example in case of higher economic growth or with less hydropower available than expected).

## Appendix 1: current cap & trade allocation rules

Current cap & trade rules cannot fulfil the objectives of the Directive on Emissions Trading mentioned above. The cap & trade theory ignores several **fundamental factors**:

- There is no equitable, scientific method to determine a cap for an individual producer. Therefore the allocation is by definition not objective although this is required by the Directive (article 9). With this observation it is fully clear and statistically understandable that allocation methods differ from one Member State to another. The absence of a scientific method to determine caps is also found in the current guidance note on allocation of the EU Commission in which many options are allowed. This leads to uncertainty: lack of predictability for operators, it undermines the effectiveness and by its very nature, causes competitive distortions between operators in different Member States.
- Most theoretical models about cap & trade ignore that there are two major factors determining the effectiveness of a trading scheme for investments to reduce emissions:
  - ✓ The CO<sub>2</sub>-price;
  - ✓ The driving force to stimulate to undertake action.
 The latter factor is most often ignored. It is assumed that actors are stimulated to invest to reduce emissions equally whether they are confronted with a small or a high driving force. In the case of historical grandfathering, as usually applied, an inefficient plant receives almost sufficient allowances; there is a small driving force. When they get a shortage of allowances that reflects the potential to reduce emissions – in accordance with the polluter-pays principle – there is a high driving force, the same stimulus as under auctioning. It is clear that in the former case producers are hardly stimulated to undertake investments to reduce emissions; this is one reason why inactivity can now be observed amongst operators.
- In addition, operators are discouraged to undertake investments to reduce emissions because lower emissions will inevitably come into the reference of the allocation of allowances for a future trading period (updating). And there is uncertainty about which years could become the reference. It is a fundamental flaw that early action is most often not rewarded, and under the current rules it is likely to happen again.
- Current rules are favouring the electricity sector with windfall profits at the expense of the other industrial sectors in and outside the scheme as well as the consumer. On the one hand internalisation of environmental cost is part of the cap & trade theory – and therefore the problem was well known beforehand – but on the other hand the magnitude of the transfer of wealth was not sufficiently recognised. Another observation is that although cap & trade were in the mind of the drafters of the Directive, unduly favouring of sectors and companies is forbidden by the Directive. And there is also a problem with the polluter-pays principle.
- A most fundamental flaw is that a winner of market share is hampered, as he needs to buy allowances while the loser can sell allowances. This hampers innovation and enhances frozen market shares. The problem of frozen market shares encompasses in fact a great number of the fundamental problems of the cap & trade theory, such as rules about new entrants and closures. The enhancement of frozen market shares is in conflict with the EC Treaty: the rules about competitive distortion and state aid. This particular form of state aid clearly affects the trade between Member States and is therefore incompatible with the common market.
- Giving a relatively high amount of allowances for high polluters does not comply with the polluter-pays principle (EC Treaty). For the electricity sector it is the *polluter-earns principle*. The explanatory memorandum of the proposed draft Directive (2001) clearly states that that draft complies with the polluter-pays principle. This means that the implementation of the Directive – unfortunately supported by the guidance note, which is legally non-binding – has not been executed correctly.

The comparison with auctioning is relevant, as it is undisputed as the ideal economic method<sup>9</sup>:

- ✓ There is no problem with objectivity, operators have no uncertainty;
- ✓ The effectiveness of the scheme is clear by the two factors, the CO<sub>2</sub>-price and the driving force fully related to the potential to reduce emissions of each operator;
- ✓ Early or later investments to reduce emissions will always have their benefit;
- ✓ There are no windfall profits for fossil-fired electricity (but there is a reward for carbon free technologies such as nuclear and renewables);
- ✓ Frozen market shares are not enhanced, innovation is clearly stimulated;
- ✓ Auctioning complies with the polluter-pays principle.

More specifically, the cap & trade theory fails for **new entrants and closures**:

- According to the theory, new entrants need to buy all allowances and allowances are retained for the operator when closing down a plant. The theoretical point of view is that the cap (overall and therefore individually) must be kept intact. Otherwise closure of inefficient installations is hampered as producers are supported to keep obsolete plants alive longer instead of shorter.
- No allowances for a new entrant means by definition no equal treatment with incumbents. This point is admitted in the current guidance note, but it is “only for a short period”.
- But the theory does not stipulate how long allowances may be kept for closures and how long new entrants must buy allowances. In practice it makes a great difference whether this is for a small period – for example one year – or for a long period. For example, a new entrant in the 4<sup>th</sup> year of a trading period may well need to buy allowances for 7 years as the 4<sup>th</sup> year may not be in the reference for the next trading period. Therefore there is always an uncertainty, the cap & trade theory gives nothing to hold on.
- In this way a new entrant who operates on the global market can be deterred. By having to buy all allowances he will then shift the investment outside the EU and no contribution will have been made to the global stabilisation of greenhouse gas concentrations.
- And no allowances for a new entrant means also a great drawback for the proliferation of novel and more efficient technologies also required by the Directive. It highlights the unequal treatment between incumbents and new entrants.

Therefore all Member States applied reserves for granting allowances to new entrants and in virtually all Member States allowances are withheld after closure. But current rules with **reserves and no allowances after closure still lead to problems of a practical or fundamental nature** in relation to incumbents, which do not change their production:

- To apply for the reserve of new entrants many rules contain thresholds (e.g. Netherlands: more than 10% expansion and more than 10 kton CO<sub>2</sub>/year additional emission). Such thresholds are arbitrary and the cap & trade theory gives no solution. This means unequal treatment with unchanged incumbents and also that capacity creep projects are not stimulated but penalised; this hampers economic and environmental progress. This practical problem can easily be solved by not allowing the use of any threshold anymore (to be communicated in the forthcoming guidance note).
- The limited nature of the new entrants’ reserve causes unpredictability for investors and creates the fundamental problems mentioned above when the reserve is depleted. So far only Germany and reportedly Poland and Italy guarantee allowances for new entrants when the reserve is depleted. The limitation in all other Member States must be eliminated for the 2<sup>nd</sup> trading period. It may seem negligible for the industry as a whole, but it is insurmountable for an individual operator when decisions are made for investments in new plant capacity.
- Some Member States admitted a transfer arrangement (e.g. Germany); allowances from a closed plant can be transferred to a new plant, which is usually more efficient. This clearly stimulates investments to lower emissions, but the fundamental objection remains: unequal treatment with other producers that have no obsolete plant to close. Again, the theory of cap & trade provides neither an objective solution nor predictability.
- Current rules have as effect that closure and shift of production to remaining more efficient existing plants is penalised instead of stimulated; for the existing plants

<sup>9</sup> This comparison is often used, also by this author; see for example the recent CHP study by Ilex Energy Consulting (August 2005) in a final report to the UK ministry Defra (page 32).

allowances must be bought (or less can be sold) as they are faced with a frozen cap. This is a fundamental problem of the theory of cap & trade.

In conclusion, the theory of cap & trade does not provide for solid solutions regarding new entrants and closures and winners and losers of market with existing installations. A reserve for new entrants and no allowances after closure are in fact contrary to this theory.

Taking away allowances after closure is as perfect a coupling to production as is granting allowances to new entrants to a great extent (because the future production is unknown to the legislator and the producer). But this relation with the production is only when 0% or something like 100% of production is realised. All situations between 0% and 100% are ignored with frozen caps.

Another dimension is that allocation rules in most Member States treat incumbents and new entrants completely different and there is no relation to the carbon efficiency of power plants:

- ◆ Incumbents usually get their allocation on the basis of historical emissions – exactly how is different in different Member States – multiplied by a general reduction factor;
- ◆ There is most often no differentiation between efficient<sup>10</sup> and inefficient incumbents. The potential to reduce emissions is not based on the individual operator but on the population of installations as a whole<sup>11</sup>.
- ◆ New entrants – most often with a much better efficiency than incumbents – are kept short of allowances based on restrictive benchmarks, or they get fewer allowances if they need fewer but with a certain minimum (Germany<sup>12</sup>) or even “never more than needed”, so no minimum (Netherlands).
- ◆ Allowances for new power plants are usually not related to the carbon efficiency, therefore coal-fired or lignite fired plants get far more allowances than gas-fired plants.

The current approach is in sharp contrast with what would happen under auctioning. Inefficient incumbents would have a strong driving force to undertake improvements of efficiency or to replace inefficient plants earlier. Efficient incumbents and efficient new entrants have a clear advantage because they cause a lower emission per unit of product.

The current allocation rules lead fundamentally and in practice to a scheme that is not effective by the lack of driving force, a conflict with the polluter-pays principle:

- ◆ CHP is hardly stimulated (while it should be according to the Directive);
- ◆ New coal-fired or lignite-fired electricity plants get their allowances, while the carbon efficiency is poor, leading to a problem with the objective to lower emissions.
- ◆ Current allocation rules of virtually all Member States – either as new entrants or later as incumbents – fail completely for zero emission plants (such as clean coal).

In conclusion, current cap & trade allocation rules do not stimulate lowering of emissions in practice. They even work out as obstacles. The fundamental problems – of incumbents and of new entrants and closures – cannot be resolved within the theory of cap & trade. The fundamental failure is that the amount of allowances is decoupled from future production.

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<sup>10</sup> It is reported that very efficient incumbents, for example CHP and modern gas-fired combined cycle plants in the UK, get a significant shortage of allowances caused by the general reduction factor.

<sup>11</sup> This practice is not only allowed but even suggested by the current guidance note on allocation by the EU Commission. It is vital that this be modified.

<sup>12</sup> In order to accommodate investments in new plants, Germany also grants allowances for a period of 12 years with a guaranteed reduction factor of 1.0; this is positive in general but it fails to provide for an effective scheme. Moreover, granting the required allowances to coal and lignite power plants is counterproductive. With PSR or auctioning the assurance of a long period like 12 years is immaterial.







## Effectiveness and fuel switch under different ETS options for electricity

24 February 2006

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### Introduction

In this paper fuel switch and effectiveness of an emissions trading scheme are elaborated under different options for the allocation of allowances. The basic options are (1) the present cap & trade, (2) auctioning and (3) PSR with ex-post control of production (Performance Standard Rate). Some relevant variations on these basic options are considered as well.

Chapter 1 shows how fuel switch occurs in all three options at the same price for CO<sub>2</sub>. In chapter 2 some telling examples are presented evaluating the effectiveness of the scheme under different allocation options.

### 1. The fuel switch mechanism

An emissions trading scheme (ETS) is a credible environmental instrument only, if there is a shortage of emission allowances in the market at a meaningful price of CO<sub>2</sub><sup>1</sup>. This shortage will be covered by short term measures such as good house keeping and in the EU ETS by the purchase of credits from realised projects of the Kyoto flexible instruments (JI and CDM). Investments to reduce emissions significantly, need a lead time of at least 4-5 years. The remaining actual shortage will then be covered by fuel switch in existing installations. Fuel switch functions as a safety valve to maintain liquidity in the market for allowances. Mainly the production of electricity is switched from existing coal- and lignite-fired power plants to gas-fired power plants, which have roughly half the emission per MWh produced. In an effective scheme, medium term (4-5 years) investments are carried out. They are needed to offset a lower cap in a following trading period. Fuel switch however remains important to maintain a liquid market for allowances.

#### 1.1. Cap & trade (frozen caps for individual operators)

In this system the price of CO<sub>2</sub> is taken fully into account (opportunity-cost) while the allowances are granted free of charge as a cap for each individual operator. After fuel switch, the lower gross margin in € mln/year caused by a lower production of a coal-fired<sup>2</sup> power plant is compensated by additional revenues from sales of allowances (or less purchases) and by the higher electricity price caused by the opportunity-cost plus a small extra margin (for example €2/MWh). This extra margin after fuel switch is needed to make the cash flow of a coal-fired plant after fuel switch equal to the cash flow before fuel switch<sup>3</sup>. A gas-fired plant with higher production needs to purchase additional allowances (or can sell fewer allowances) which is compensated for by the higher electricity price.

The prices for CO<sub>2</sub> and electricity rise until equilibrium in the market is achieved to enable fuel switch. The fuel switch prices for CO<sub>2</sub> and electricity are governed by the prices for gas and coal and by the efficiencies of the plants of which fuel switch is needed to overcome the shortage in the market. In addition, the cost of fuel switch is optimised against the cost of purchasing JI- and CDM credits. When fuel switch is expensive, a higher price can be paid for these credits and vice versa lower credit prices lower the need for fuel switch.

<sup>1</sup> At persistently low CO<sub>2</sub>-prices, for example € 5-10/ton, the influence of emissions trading to reduce emissions is rather low as the potential investments are virtually not worthwhile.

<sup>2</sup> When in this paper 'coal-fired' is mentioned, this is also valid for 'lignite-fired'.

<sup>3</sup> See "Options and consequences for the allocation of allowances to electricity producers" of 21 December 2005 of this author, page 8.

### 1.2. Auctioning (allowances are auctioned to participants)

Under auctioning the price of CO<sub>2</sub> is taken fully into account as well, but now the CO<sub>2</sub>-costs are hard variable costs. Therefore there is competition on margins in the market between all power plants; the impact of opportunity-costs is eliminated.

Let's assume that these margins are € 7/MWh and € 15/MWh for the marginal power plants fired with gas and coal respectively. Compared with cap & trade, the shortage of allowances is overcome by fuel switch at exactly the same price for CO<sub>2</sub> and the same slightly higher price for electricity (the needed extra margin, depending on the stringency of the total cap, in other words the total of allowances up for auction and the respective efficiencies of the fuel switching plants<sup>4</sup>).

Without emissions trading, a coal-fired plant has an increased gross margin (in €/MWh) when more expensive gas-fired power plants are marginal. This could be characterised as a "secondary" windfall profit. With emissions trading, the cost price advantage of coal-fired power plants over gas-fired plants will decrease as the CO<sub>2</sub>-price increases (under auctioning the coal-fired plant must buy about twice the quantity of allowances per MWh compared with the gas-fired power plant).

At the fuel switch CO<sub>2</sub>-price, the marginal power plants (gas- and coal-fired) have the same electricity market price. After fuel switch the higher production of a switching gas-fired plant causes a higher total margin in € mln/year for this plant (higher production times a slightly higher gross margin (explained below) in €/MWh).

Without a small extra margin, the lower production of the coal-fired plant after fuel switch at the equilibrium fuel switch price for CO<sub>2</sub> would cause the same gross margin per MWh (assumed € 15/MWh) and hence a decrease of total margin in € mln/year. Therefore to enable the fuel switch, the electricity price must slightly increase to compensate for this loss of total margin.

The needed small increase of the electricity price notwithstanding, the accumulated gross margin of coal-fired plants measured in € mln/year decreases. The reason is that there is no "secondary" windfall profit anymore.

### 1.3. Performance Standard Rate (PSR)

Under PSR – one PSR for fossil-fuelled electricity with ex-post control of production – the price of CO<sub>2</sub> is also taken fully into account, and again the CO<sub>2</sub>-costs are hard variable costs. The market functioning is the same as under auctioning, PSR is a kind of partial auctioning.

Under auctioning, operators need to buy all allowances, but under PSR they all get an equal quantity of allowances granted for free – say 700 kg CO<sub>2</sub>/MWh – for each MWh that they actually produce. Therefore there is competition on margins in the market between all power plants without the occurrence of opportunity-costs.

The text under auctioning above (starting from "Let's assume ..." until the end) is also valid for PSR emissions trading.

To switch fuels, as under cap & trade and auctioning, the required CO<sub>2</sub>-price depends on the price differential between coal and gas and the efficiencies of the fuel switching gas-fired and coal-fired plants. The CO<sub>2</sub>-price must be high enough that the gas-fired plant comes at par with the coal-fired plant. Only then the gas-fired plant can produce and sell more electricity.

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<sup>4</sup> See "Options and consequences for the allocation of allowances to electricity producers" of 21 December 2005, page 34-35.

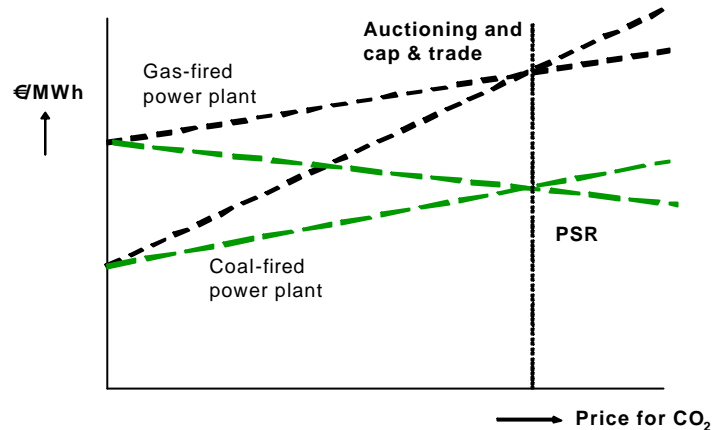
There is one essential difference with cap & trade or auctioning: the variable costs of gas-fired power plants decrease instead of increase (because the emission is lower than PSR) while the variable costs for coal- and lignite power plants (emission higher than PSR) increase less than under auctioning. This combined effect virtually eliminates the price increase of electricity caused by emissions trading, schematically presented below<sup>5</sup>.

Fuel switch occurs under PSR as follows:

At increasing CO<sub>2</sub>-prices gas-fired electricity becomes cheaper and allowances from these plants are sold to coal-fired plants which need them. At the equilibrium price for CO<sub>2</sub> and after a slight increase of the electricity price it becomes economical for a coal-fired plant to lower production: the needed small extra increase of the

electricity price compensates for the loss of margin caused by the lower production, exactly the same as under auctioning.

### Fuel switch under different options



#### 1.4. Variations on the basic allocation options

Variations on the previous three basic allocation options are set out succinctly.

##### ***Ex-ante (skewed or not) allocation with fuel specific PSRs***

With ex-ante allocation the scheme is still cap & trade, fuel switch works as described. This option can be considered as a slight deviation from historical grandfathering. Skewed allocation works the same, but now the electricity industry gets a lower cap (for example 25%-40%) to compensate industries for the increased electricity prices<sup>6</sup>.

##### ***Ex-ante (skewed or not) allocation with one PSR***

Again the scheme is still cap & trade. Fuel switch works accordingly.

##### ***Fuel-specific PSRs with ex-post control of production***

If there would be three PSRs (for gas, coal and lignite) the potential for fuel switch would be cut by more than 2/3. This lowers the liquidity of the market of allowances significantly. The reason is that coal-fired electricity of plants better than the PSR-coal cannot be substituted by any gas-fired electricity. It is even so that coal-fired electricity from plants better than the PSR can substitute gas-fired electricity worse than the PSR-gas.

Because of the lower incentive compared to one single PSR and auction, much higher CO<sub>2</sub>-prices are needed to enable fuel switch. At the current price differential between coal and gas fuel switch prices would be above €500/ton CO<sub>2</sub>. Electricity price will be erratic, sometimes normal and sometimes very high<sup>7</sup>.

<sup>5</sup> Courtesy Mr Giuseppe Astarita of Federchimica.

<sup>6</sup> This compensation works poorly as more than 45% of electricity in the EU-25 is based on nuclear and renewables and because there is no compensation for industries outside the ETS (e.g. aluminium).

<sup>7</sup> See "Options and consequences for the allocation of allowances to electricity producers" of 21 December 2005, page 39-40.

## 2. Allocation options and the effectiveness of the scheme

PSR provides for a robust, predictable and effective emissions trading scheme. Just as under auctioning market signals are crystal clear. For example, there are no problems with new entrants – which contribute to a more efficient production park – and there is no problem between companies competing for market share. Three other examples are introduced below.

### 2.1. Combined Heat & Power (CHP)

CHP is hardly or not stimulated under the present allocation rules in most Member States<sup>8</sup>. For example, in Germany the planned reduction through CHP of 20 Mton/year for 2010 will not even be met for 50%<sup>9</sup> with current allocation rules despite the present subsidies.

In contrast, the Directive states that energy efficient technologies, such as CHP, will be stimulated (recital 20). This would happen indeed with auctioning.

With PSR and ex-post control of production, CHP plants will have an extra competitive advantage and will be pushed into a more favourable position in the merit order. At a starting PSR of around 700 kg CO<sub>2</sub>/MWh, a CHP plant can sell about 450 kg CO<sub>2</sub>/MWh. This represents a value of € 11/MWh at € 25/ton CO<sub>2</sub>. This means that CHP is virtually always more economical to run if compared to coal-fired power plants. Therefore, PSR will function as an incentive to further growth of CHP, as under auctioning.

With ex-ante allocation and one single PSR the spur is in principle the same as under PSR with ex-post control of production. The price of electricity will be the same as under cap & trade. In addition, there will be problems when a CHP plant had a low utilisation rate in a historical reference period.

Under fuel-specific PSRs the stimulation of CHP will be taken away to a large extent. This is valid for ex-ante and for ex-post allocation. At higher gas prices as foreseen now, CHP cannot compete with modern coal-fired power plants.

### 2.2. Efficiency improvements of existing power plants and transfer rules

Efficiency improvements of existing power plants are most needed for plants with the worst efficiency, the marginal power plants in the market. Another option is to replace inefficient units by state-of-the art plants. In some Member States transfer rules are applied: the allowances of the replaced plant are transferred for a certain period to the new plant.

The problem with an efficiency improvement or a replacement is that the decrease of opportunity-cost is higher than the decrease of fuel cost<sup>10</sup>; such investments have a negative return on investment. Transfer rules overcome this problem, but only for replacements and a short period. Furthermore, there is a competitive distortion and a barrier to entry. A new entrant without an obsolete plant to close gets fewer allowances for the same new plant.

Under PSR the rewards are clear: the fuel costs decrease and more allowances can be sold or less need to be purchased, again as under auctioning.

### 2.3. Zero emission versus conventional power plants

The present cap & trade allocation rules fail for zero emission power plants<sup>11</sup>, such as clean coal or clean gas plants. This is also recently asserted by Euracoal, the European Association for Coal and Lignite, together with a plea for longer trading periods<sup>12</sup>. However, long trading periods like 25-40 years are not feasible as these would lead to an

<sup>8</sup> See “Options and consequences for the allocation of allowances to electricity producers” of 21 December 2005, page 23.

<sup>9</sup> Point Carbon Daily, 14 February 2006.

<sup>10</sup> See the same report as under footnote 6, page 27.

<sup>11</sup> See the same report as under footnote 6, page 26.

<sup>12</sup> Point Carbon Daily, 24 January 2006.

unmanageable system for new entrants leading to entry barriers and competitive distortions between incumbents and new entrants.

Under any system of cap & trade rules there is no incentive through higher electricity prices, this effect is the same for conventional and zero emission power plants. Therefore the incentive must come from the allocation of allowances. This incentive is usually zero because most often zero allowances are received<sup>13</sup>. The difference with PSR is illustrated below:

Kg CO <sub>2</sub> /MWh	Present cap & trade rules			PSR, assume 650 after some years		
	Coal (47%)	Clean coal	Incentive	Coal (47%)	Clean coal	Incentive
Allocation as new entrant						
Allowances	720	0		650	650	
Need	720	0		720	0	
Surplus	0	0	<b>0</b>	-70	650	<b>720</b>
Allocation as incumbent						
Allowances	<= 720	0		650	650	
Need	720	0		720	0	
Surplus	<= 0	0	<b>&gt;= 0</b>	-70	650	<b>720</b>

The higher costs of a clean coal plant have two causes: (1) higher fuel costs, probably around €2-3/MWh, because energy is needed for carbon capture, compression of CO<sub>2</sub> and possibly the manufacture of oxygen; (2) the higher investments for carbon capture, compression and transport of CO<sub>2</sub> and possibly the oxygen plant.

Vattenfall mentions a total cost price increase from €32.4/MWh to €49.5/MWh excluding transport and injection costs<sup>14</sup>, which would result in €137 mln/year additional cost for a 1000 MWe plant (8000 hrs/year). This would correspond with €20/ton CO<sub>2</sub>, therefore with an allocation incentive of 855 kg CO<sub>2</sub>/MWh. When compared to the 47% efficiency reference plant, the incentive is 720 CO<sub>2</sub>/MWh and the needed CO<sub>2</sub>-price would be €24/ton CO<sub>2</sub> (excluding transport and injection cost for CO<sub>2</sub>).

Under the present cap & trade rules, there are always historical emissions in the reference; benchmarks do not help. Ex-ante allocation based on historical production and one single PSR would solve this problem, but the higher electricity prices would remain the same.

Ex-ante allocation and fuel-specific PSRs would also have higher electricity prices like today and there would be a great incentive for zero emission power plants. However, CHP would not be stimulated sufficiently and building new conventional coal-fired electricity plants can go on while the emissions are supposed to be reduced.

Ex-post allocation with fuel-specific PSRs would lead to extremely high CO<sub>2</sub>-prices, to erratic electricity prices but clean coal and clean lignite power plants would be stimulated. Again like with ex-ante allocation, CHP will not be stimulated sufficiently and building new conventional coal-fired electricity plants can go on while the emissions must go down. Fuel-specific PSRs are in contradiction with the objective function of the scheme.

## 2.4. Conclusion

The incentives of one PSR with ex-post control for CHP, investments for efficiency improvements and zero emission plants are the same as under auctioning. This coincides with the spirit and requirements of the Directive. PSR provides a robust, predictable and effective trading scheme.

<sup>13</sup> In Germany (most likely) allowances are available for the minimum threshold of 365 kg CO<sub>2</sub>/MWh, but only as new entrant, an incentive of €9.1/MWh at €25/ton; while the additional fuel for a clean coal plant needs €2-3/MWh, an annual incentive of about €50-55 mln is left for a base load plant of 1000 MWe to justify the additional investments. This is not enough and no incentive to an incumbent.

<sup>14</sup> See Vattenfall's newsletter on the CO<sub>2</sub>-free power plant project, November 2005.